U.S. Department
of Transportation

Federal Aviation Administration

Memorandum

Subject: **ACTION**: Review and Concurrence, Equivalent Level of Safety Finding for Cessna New Model 680
FAA Project #TC2548WI-T

Date: May 3, 2004

Reg Ref: §§ 25.857, 25.1195

From: Manager, Propulsion/Mechanical Systems Branch, ANM-112

Reply to Attn. of: Bob Busto, ACE-116W

To: Manager, Wichita Aircraft Certification Office, ACE-115W

ELOS Memo #: TC2548WI-T-SG-1

Background

Cessna Aircraft Company is certifying the Model 680 Sovereign for takeoff and landing at airports with elevations up to 14,000 feet. Per § 25.841(a), under normal operating conditions, the cabin pressure altitude cannot exceed 8,000 feet. Section 25.841 (b)(6) requires crew warning indication when the cabin pressure altitude exceeds the safe or preset pressure differential and cabin pressure altitude limits are exceeded. The rule states that the warning requirement for cabin pressure altitude limits may be met if the warning is set for 10,000 feet. Use of this accepted setting would result in nuisance altitude warnings during takeoff and landing at airports above 10,000 feet. Special design features are needed to reset the cabin pressure altitude warning system to be acceptable for this type of aircraft operation. Cessna, therefore, has designed a Cabin Environmental and Pressurization Control System that shifts the cabin pressure altitude warnings under specific conditions for these high altitude operations.

The cabin altitude must equal the airport elevation when departing or landing. Cessna has installed a controller, which will allow normal takeoffs and landings and those at elevations between 8,000 feet and 14,000 feet for the Model 680 Sovereign. The cabin pressure control system for the Model 680 Citation Sovereign incorporates a discreet electrical signal from the cabin pressure controller any time an altitude above 8,000 feet is selected and aircraft altitude is less than 24,500 feet and the cabin altitude is above 8,000 feet. This discreet signal shifts the red altitude-warning message (an EICAS function) from 10,000 feet to 14,500 ± 490 feet cabin altitude. It also shifts the amber altitude-warning message from 8,500 feet to 14,500 ± 490 feet cabin altitude. This is done to prevent distraction to the crew during landing at a high altitude airport. However, this feature prevents literal compliance with §25.841(b)(6).

In the way of clarification, if the aircraft altitude climbs above 24,500 feet or if the cabin altitude drops below 8,000 feet, the discreet signal discussed above is removed and the cabin altitude warnings revert to their original settings.

Applicable regulation(s)

§ 25.841(b)(6) – Pressurized cabins

Regulation requiring an ELOS

Section 25.841(b)(6) – Pressurized cabins

Description of compensating design features or alternative standards, which allow the granting for the ELOS (including design changes, limitations or equipment need for equivalency)

1. To assure that the cabin altitude will not exceed 8,000 feet any time the aircraft altitude is greater than 25,000 feet, the cabin pressure controller incorporates the following rate of change multipliers, which affect the selected rate when the discreet signal is active:
   (a) If the selected landing altitude is between 8,000 and 11,000 feet, the multiplication factor = 1.66.
   (b) If the selected landing altitude is between 11,000 and 14,000 feet, the multiplication factor = 2.80.

2. When the aircraft is descending for landing at an airport altitude greater than 8,000 feet, the controller does not allow the cabin altitude to rise above 8,000 feet until the aircraft altitude descends below 24,500 feet.

3. The outflow valves each incorporate a pneumatic altitude limit feature that overrides any other control input. The altitude limit features are set to limit cabin altitude to 14,250 ± 750 feet.

4. When taking off from an airport higher than 8,000 feet with a selected landing altitude less than 8,000 feet, the discreet signal and the rate multipliers are active until the aircraft exceeds 24,500 feet or until the cabin altitude drops below 8,000 feet, whichever occurs first.

5. The automatic passenger oxygen mask drop feature is set to occur at 14,500 ± 490 feet.

6. The software in the controller incorporates a feature that illuminates the fault light on the cabin pressure control selector and automatically transfers the system to manual mode if the discreet signal mentioned previously is present due to a failure condition. Logic was added to the CAS to prevent cabin altitude warnings from being shifted to the High Altitude Airfield Mode settings for more than 30 minutes in flight. A cyan message is posted whenever cabin altitude warnings are shifted to High Altitude Airfield Mode settings and cabin altitude does not exceed 14,500 FPA. If the cabin altitude is above 9650 ft for more than 30 minutes in flight, the cyan message changes to amber, accompanied by the single chime and MASTER CAUTION.

7. The CAS logic has been modified to prevent automatic shift of the cabin altitude warning setting when the High Altitude Airfield Mode is not required.

8. The flight manual procedure requires crew use of supplemental oxygen if the cabin altitude is above 9,650 feet after the CPCS has been in High Altitude Airfield mode (Cabin Altitude warning settings shifted above their normal settings) for more than 30 minutes. The AFM also includes wording that recommends the use of supplemental oxygen after prolonged exposure to a cabin altitude in excess of 12,000 feet by at least one pilot. In addition, in the oxygen system description portion of the AFM, Cessna provides additional advisory information informing the flight crew of operating rule requirements with respect to time, cabin altitude and the use of supplemental oxygen.

Explanation of how design features or alternative standards provide an equivalent level of safety intended by the regulation

As compared to many previous Cessna aircraft, which reset or suppressed pressurization warnings by manual procedures, this system reduces pilot workload and provides automatic warning and safety backups. Detailed below is an explanation on how each design feature presented above supports an equivalent level of safety finding:

1. By increasing the cabin pressure rate of change, exposure to cabin altitudes in excess of 8,000 feet is minimized. The rates are such that by the time the aircraft altitude exceeds 25,000 feet the cabin altitude is at or below the required 8,000 feet. During descent into a high altitude field the increased cabin rate of change minimizes the likelihood of landing pressurized. At no point during this type of operation does the cabin altitude exceed 15,000 feet. This mode of operation is only active when the discrete signal is active.

2. By not allowing the cabin altitude to exceed 8,000 feet until the aircraft has descended below 25000 feet during a high altitude landing, minimizes the occupant's exposure to cabin altitudes in excess of 8,000 feet. At no point during this type of operation does the cabin altitude exceed 15,000 feet.

3. The pneumatic altitude limit feature built into each outflow valve limits cabin altitude to 14,250 ± 750 feet. This altitude limit feature operates independently of any other control input. If a landing at 14,000 feet altitude is made with worst tolerance altitude limits on both outflow valves, the max differential cabin pressure at landing might be + .18 psid. The main entry door vent relief feature is effective at up to + .50 psid, therefore, exit from the aircraft can be accomplished if the ECU's are operating.

4. By increasing the rate of change of cabin pressure when performing a high altitude takeoff, minimizes the exposure of the occupants to cabin altitudes in excess of 8,000 feet. At no point during this type of operation does the cabin altitude exceed 15,000 feet.

5. The automatic oxygen drop feature for the passengers is not changed by the shift cabin altitude warning. Therefore, the same level of safety exist as when the operating with the cabin altitude warning setting in the normal position. The flight crew oxygen system is always available for crew use, independent of pressurization system operating mode.

6. Fault monitoring in the cabin pressure controller will annunciate failures associated with the High Altitude Airfield Mode discreet. Illumination of the fault light on the cabin pressure control selector and automatically transferring the system to manual mode will alert the crew to a problem in the pressurization system and force the crew to monitor the cabin altitude gage. Thus, precluding an undetected failure of the discreet.

7. By adding logic to the CAS to monitor the status of the High Altitude Airfield Mode alerts the crew in two ways. First, the cyan advisory message alerts the crew that the system is in the high altitude airfield operating mode and the warnings are shifted. Secondly, changing the cyan advisory message to an amber caution message after 30 minutes of operation in the high altitude airfield mode alerts the crew that they have been exposed to elevated cabin altitudes for an extended duration and that oxygen should be used.

8. Modifying the CAS logic to prevent the automatic shift when the High Altitude Airfield Mode is not required, was done in lieu of adding annunciation of the failure of the automatic shift of cabin altitude warning settings. The existing Amber and Red CABIN ALTITUDE CAS messages provide adequate alert to the crew to take appropriate action. Additionally, for any loss of power or ARINC inputs, the existing CPCS controller software will cancel the High Altitude Airfield Mode output, which will cause the cabin altitude warnings to shift back to the normal settings. If the cabin altitude was above 8500 ft, the Amber CABIN ALTITUDE CAS would immediately be posted. If the cabin altitude was above 9650 ft, the Red CABIN ALTITUDE CAS would immediately be posted. The existing Amber and Red CABIN ALTITUDE CAS messages provide adequate alert to the crew to take appropriate action.

The CPCS controller software prevents the High Altitude Airfield Mode signal from being sent to the CAS if the airplane is at 8000 Ft or below or above 24,500 ft. Additional logic was added to the CAS to latch out cabin altitude warning shift to the High Altitude Airfield Mode settings if the signal was present after power up at any time at 8000 Ft or below or above 24,500 ft. This will prevent the CAS from shifting the cabin altitude warnings due to an incorrect signal from the CPCS controller whenever the airplane is above 24,500 ft. A Red CABIN ALTITUDE CAS warning message would be provided if cabin altitude exceeded 9650 ft when the airplane is above 24,500 ft, which will provide adequate alert to the crew to take appropriate action.

9. The addition of information into the aircraft flight manual ensure that flight crews are provided with the required procedures and cautions when operating in the High Altitude Airfield Mode.

Additionally, Cessna has shown through the system safety process that failures associated with the shift of cabin altitude warning to the higher setting in combination with a decompression event are extremely improbable.

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned Equivalent Level of Safety Finding in Issue Paper SG-1. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The Transport Directorate has assigned a unique ELOS Memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum Number should be listed in the Type Certificate Data Sheet under the Certification Basis section. [E.g. Equivalent Safety Findings have been made for the following regulation: § 25.841(b)(6) – Pressurized cabins (documented in TAD ELOS Memo TC2548WI-T-SG-1)]

/s/

Signature: Neil D. Schalekamp

Manager, Propulsion/Mechanical Systems Branch, ANM-112

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ELOS Originated by Wichita ACO:	Program Manager, Tina Miller	Routing Symbol ACE-117W